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Full Depth Reclamation for Deteriorated Hot Mix Asphalt Pavement

WAUKESHA COUNTY AIRPORT / CRITES FIELD WAUKESHA, WI

Full Depth Reclamation [FDR] – A Rehabilitation Option for Deteriorated Hot Mix Asphalt [HMA] Pavements

Crites Field

Crites Field, the local and historic name for the Waukesha County regional airport, has been growing in both air traffic and in importance to the Waukesha County community in general. In the past several years, take-offs and landings have increased to over 100,000 per year. The main runway, now a Portland cement concrete pavement, was reconstructed a few years ago, but the auxiliary runway [18/36], an old asphalt pavement, had deteriorated. It needed rehabilitation. The 3,600 foot runway was originally constructed on fill with a three inch hot mix asphalt [HMA] surface over only about eight inches of crushed aggregate base course. The surface was badly cracked and very rough for an airport runway, not suitable even for an auxiliary facility.

Design Options

In concert with the Wisconsin Department of Transportation Bureau of Aeronautics [BOA], Mead & Hunt, Inc., a consulting firm specializing in airport design and construction, developed two alternatives for the pavement reconstruction phase of this project. They included either removing the existing pavement, reconstructing the sub-grade, installing a geo-textile fabric, replacing the base and repaving or pulverizing / recycling the existing pavement in place, stabilizing / strengthening the material with class 'C' fly ash and repaving with four inches of new HMA pavement. The second alternative known as full depth reclamation [FDR] is rapidly becoming the HMA rehabilitation option of choice for many jurisdictions. Evaluating the bids, the FDR option was lower by over 25% compared to the more traditional construction method. After significant discussion and evaluation of the options, the BOA and Mead & Hunt's engineering staff recommended FDR based on the economic advantage and the anticipated saving of construction time. The airport manager, Keith Markano, supported selection of the FDR option, even though he had no prior experience with the process.

Mr. Markano conferred with the Waukesha County highway department, which recently used the FDR method successfully on several of their rehabilitation projects. The response was positive, making it more comfortable for him to approve the option.

Waukesha County has reconstructed several miles of trunk highways using FDR, some of which have been the basis for ongoing performance studies. One section in particular has been evaluated in each of the past five years using a falling weight deflectometer [FWD] to evaluate both pavement and base performance. Surface performance has been very good and base performance has been so good, it lead engineers to support increasing the structural number used in HMA pavement design.

Geotechnical Recommendations

To assure that the pulverized asphalt pavement [PAP] material was treated with proper concentrations of class 'C' fly ash, Soils & Engineering Services [SES] was engaged to perform lab tests on the pulverized material. Several PAP material samples were taken to the



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lab where moisture / density relationships were determined using procedure ASTM - D 1557. Optimum density was determined to be 137.7 pcf at a moisture content of 6.4%. Several Proctor points were evaluated with varying concentrations of fly ash. The recommended application of fly ash was 110 lbs. per square yard or about 8% by weight. This rate is very typical for stabilizing PAP where the range is 7 – 11% fly ash and in the range of 6 – 8.5% moisture. Other materials on site were tested as well to assure performance during and after construction. Mead & Hunt engineers, the airport manager and the contractors met on a regular basis to share information, determine schedules and keep the project on track.

Construction Process

Full Depth Reclamation follows a well defined series of operations. First the existing HMA pavement is pulverized, usually to a depth of 12 inches. The HMA and aggregate base course materials below it are reduced to a combination of materials that are in effect a high grade new base course. Gradation is similar to that of a conventional crushed stone. The materials are relatively loose and need to be compacted, and re-graded to meet design requirements. Water is usually added to assure proper density. Next, the fly ash is distributed on the new surface with the vane feeders mentioned earlier. The vane feeders are calibrated to spread fly ash on the surface at the specified design rate.



Next the materials are mixed with a pulverizer to produce a homogeneous mixture of PAP and fly ash. Generally, the depth of treated material is 8 – 9 inches. Since moisture content of the mixture is crucial, a water truck is connected to the pulverizer and water is injected directly into the mixing chamber. Constant monitoring of the moisture content is required. Once the materials are mixed and blended, a vibratory pad-foot roller makes several passes over the material. It is essential that the vibratory roller follow the mixing operations as closely as practicable. In most cases, there is no delay between the mixing and the compaction. Delays will result in reduced performance of the new base material.

Next the newly blended material is graded to meet geometric requirements for cross slope, profile and curvature, if any. After that it is rolled once again with a roller, this time a smooth drum roller operating in static mode. This is important because once the fly ash and water are mixed with the PAP and compacted, the process of hydration begins. It continues throughout the grading process and to apply additional vibratory loads would interfere with the hydration process. Final rolling simply seals the surface of the strengthened material and provides a smooth, uniform surface for the new HMA pavement. In some cases, several days may pass between the fly ash stabilizing and construction of the new HMA surface. It is common to fog the finished surface with water to enhance hydration and to control dusting as the materials dry.

One advantage the FDR construction option provides is that after initial compaction and preliminary grading is complete, traffic, both construction and vehicular can traverse the work site. Other construction operations can be completed simultaneously and delivery vehicles are not impeded.



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Contractors

The prime contractor on the project was Super Excavators, Inc a regional grading and underground contractor headquartered in Menomonee Falls, WI. Payne & Dolan, Inc of Waukesha was the subcontractor responsible for the pulverizing, fly ash stabilizing and final HMA paving. Lafarge North America was the fly ash supplier and We Energies, a regional electric utility company produced the class 'C' fly ash at its Oak Creek Power Plant.

Payne & Dolan has been involved in the FDR process for many years in the area. Their equipment operators, foremen and project managers are very experienced and over time have become knowledgeable in the process, being able to sense performance of the mixed materials by the way in which the equipment behaves. Moisture content is crucial and the operators watch the mixture constantly.

Fly ash transportation from the power plant to the project site was provided by Hribar trucking. Hribar also operated the vane feeders used to distribute the fly ash on the PAP surface. The vane feeders are owned by Lafarge and are typically provided as part of the fly ash delivered to the project site. Because the completion schedule for this project was ambitious, two vane feeders were provided. By using two units, there was no time lost transferring fly ash from the tank trucks to the vane feeders. Payne & Dolan equipment was in service continuously pulverizing and blending fly ash with the PAP.

Quality Assurance

Throughout the project, Mead & Hunt engineers were on site to provide guidance to the contractors. Their technicians did all the necessary staking to provide the contractor information for final grades. In airport construction, grade tolerances are very important. And because construction progress was very fast, the technicians needed to move quickly to stay ahead of the hydration process.

The geotechnical consultant, SES, was on site throughout the project to monitor density and moisture content of the new material. The compaction recommended by SES for the PAP was 95%. In over 80 test sites, all met or exceeded the minimum design requirement. Many were in the upper ranges of compliance and several were at 100%. Moisture tests were all in the range of 6 – 9%, all in compliance with recommendations and certainly acceptable for performance. During the course of the project, heavy rain fell several times on the new base. Even with that, performance surpassed minimum requirements. The new surface shed rain as designed and continued to gain strength through hydration.

During construction of the new HMA lower course, SES monitored densities as well. With the new firm base, in all cases, design density was exceeded, a testimonial to performance of FDR material.

Environmental Considerations

The FDR project on Crites Field was completed in a very timely way. Weather did not interfere with progress and there were significant environmental advantages. The existing pavement [both HMA and base course] components were pulverized and re-used completely. No material was hauled off site and no additional natural materials were brought in. Trucking costs were minimized and over 2,000 tons of class 'C' fly ash from the utility company was



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used in a beneficial application. The fly ash used in this project was not cement replacement quality [for use in concrete] and may have otherwise been sent to a disposal site.



During construction, representatives from the Wisconsin Department of Natural Resources, the USEPA and the utility company were on site to observe the progress on the project. There was uniform agreement that the work was done in compliance with standing regulations [Wisconsin administrative code NR 538] and policies of the utility itself. Wisconsin Department of Transportation specification policies and procedures were followed as well. The vane feeders used to spread the fly ash on

the PAP surface are designed to control the application rate, but also are very effective in minimizing or eliminating fugitive dust. The representatives also agreed that projects that utilize the FDR option will continue to become more attractive. With the price of asphalt continuing to increase, this alternative will find its way into the construction industry.

Economic Considerations

Full Depth Reclamation utilizes existing materials which were paid for during initial construction and class 'C' fly ash. The typical cost for the FDR process, including pulverizing, spreading fly ash, mixing, watering, compacting and grading to paving grade is approximately \$4.50 per square yard, complete and ready to pave. On this project the cost of traditional construction was estimated at \$200,000. The final cost of the FDR option saved the taxpayers of the state and county over \$50,000. In addition, selecting this option saved substantial construction time.

Over 30,000 square yards of material were pulverized and stabilized with fly ash in only six days. It allowed the project to move forward very quickly with no delays caused by rainy weather. And while cost is somewhat difficult to estimate, air traffic interruption due to construction was held to a minimum.

Conclusions

In discussing the project with the airport manager, Mr. Markano, he expressed his pleasure and satisfaction with the choice. He had the support of the Waukesha County Executive and his staff. His satisfaction and the satisfaction of his customers, the pilots and passengers that use the facility are very important. One feature of the FDR process he was pleased with is very short construction time.



This was the first major project of this type for the Bureau of Aeronautics and the engineer, Mead & Hunt. Both expressed satisfaction with the performance of the FDR process and the cost advantages it exhibited. They learned many of the details of construction, materials and



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procedures. It appears that as work on other general aviation airports in the state becomes necessary, this option will begin to become the primary design option. It already has in many county highway agencies.

The contractors are pleased with the results this project produced as well. Payne & Dolan, who has done a number of similar projects, gained additional experience with the close tolerances required by FAA specifications. The use of more than one vane feeder truly helped expedite the work. Most agree that the advantage FDR provides by eliminating the concern for rain events during the course of the work can be a real asset.

This report was prepared by James R. Rosenmerkel, P.E., engineering consultant to Lafarge North America. He spent many hours in the field with the contractors, utility representatives, engineers and regulators providing guidance and advice. Design details were provided by the various parties and are reported as received. Additional information is available at jbrosie@sbcglobal.net or at 262-547-2585.

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This coal ash utilization case study is a selection of the Coal Combustion Product Partnership. For more information, consult the C2P2 web site at <http://www.epa.gov/epaoswer/osw/conserv/c2p2/>